

a very serene air, free from smoke, which enabled him to discern and keep sight of the moon during the whole occultation, so that he might observe the moment of the emergence with the same certainty, as that of the immersion: for Mr. Canton, with a reflector of 18 inches only, that day plainly saw the moon at his house in Spital-fields.

The Greenwich Observation.

Apparent time.	h	'	"	
1751 April 15,	22	41	45	The first contact; doubtful to 1 second.
		42	18	Quite immersed.
	23	15	36½	Began to emerge.
		16	8½	Wholly emerged.
16,	1	39	12	Venus passed the meridian.

J. Short.

XXXI. *An Account of Mr. Benjamin Franklin's Treatise, lately published, intitled, Experiments and Observations on Electricity, made at Philadelphia in America; by Wm. Watson, F. R. S.*

Read June 6. 1751. **M**R. Franklin's treatise, lately presented to the Royal Society, consists of four letters to his correspondent in England, and of another

other part intituled “ Opinions and conjectures concerning the properties and effects of the electrical matter arising from experiments and observations.”

The four letters, the last of which contains a new hypothesis for explaining the several phænomena of thunder-gusts, have either in the whole or in part been before communicated to the Royal Society. It remains therefore, that I now only lay before the Society an account of the latter part of this treatise, as well as that of a letter intended to be added thereto by the author, but which arrived too late for publication with it, and was therefore communicated to the Society by our worthy brother Mr. Peter Collinson.

This ingenious author, from a great variety of curious and well-adapted experiments, is of opinion, that the electrical matter consists of particles extremely subtil; since it can permeate common matter, even the densest metals, with such ease and freedom, as not to receive any perceptible resistance: and that if any one should doubt, whether the electrical matter passes through the substance of bodies, or only over and along their surfaces, a shock from an electrified large glass jar, taken through his own body, will probably convince him.

Electrical matter, according to our author, differs from common matter in this, that the parts of the latter mutually attract, and those of the former mutually repel, each other; hence the divergency in a stream of electrified effluvia §: but that, tho’ the

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particles

§ As the electric stream is observed to diverge very little, when the experiment is made *in vacuo*, this appearance is more owing to

particles of electrical matter do repel each other, they are strongly attracted by all other matter.

From these three things, *viz.* the extreme subtilty of the electrical matter, the mutual repulsion of its parts, and the strong attraction between them and other matter, arises this effect, that when a quantity of electrical matter is applied to a mass of common matter of any bigness or length within our observation (which has not already got its quantity) it is immediately and equally diffused thro' the whole.

Thus common matter is a kind of sponge to the electrical fluid; and as a sponge would receive no water, if the parts of water were not smaller than the pores of the sponge; and even then but slowly, if there was not a mutual attraction between those parts and the parts of the sponge; and would still imbibe it faster, if the mutual attraction among the parts of the water did not impede, some force being required to separate them; and fastest, if, instead of attraction, there were a mutual repulsion among those parts, which would act in conjunction with the attraction of the sponge: so is the case between the electrical and common matter. In common matter indeed there is generally as much of the electrical as it will contain within its substance: if more is added, it lies without upon the surface ||, and forms what we call
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to the resistance of the atmosphere, than to any natural tendency in the electricity itself. *W. W.*

|| The author of this account is of opinion, that what is here added, lies not only without upon the surface, but penetrates with the same degree of density the whole mass of common matter, upon which it is directed.

an electrical atmosphere ; and then the body is said to be electrified.

'Tis suppos'd, that all kinds of common matter do not attract and retain the electrical with equal force, for reasons to be given hereafter ; and that those called electrics *per se*, as glass, &c. attract and retain it the strongest, and contain the greatest quantity.

We know, that the electrical fluid is in common matter, because we can pump it out by the globe or tube ; and that common matter has near as much as it can contain ; because, when we add a little more to any portion of it, the additional quantity does not enter, but forms an electrical atmosphere : and we know, that common matter has not (generally) more than it can contain ; otherwise all loose portions of it would repel each other, as they constantly do when they have electric atmospheres.

The form of the electrical atmosphere is that of the body, which it surrounds. This shape may be render'd visible in a still air, by raising a smoke from dry resin dropp'd into a hot tea spoon under the electrified body, which will be attracted and spread itself equally on all sides, covering and concealing the body. And this form it takes, because it is attracted by all parts of the surface of the body, though it cannot enter the substance already replete. Without this attraction it would not remain round the body, but be dissipated in the air.

The atmosphere of electrical particles surrounding an electrified sphere is not more disposed to leave it, or more easily drawn off from any one part of the sphere than from another, because it is equally attracted by every part. But that is not the case with
bodies

bodies of any other figure. From a cube it is more easily drawn at the corners than at the plane sides, and so from the angles of a body of any other form, and still most easily from the angle that is most acute; and for this reason points have a property of drawing on, as well as throwing off the electrical fluid, at greater distances than blunt bodies can.

From various experiments recited in our author's treatise, to which the curious may have recourse, the preceding observations are deduced. You will observe how much they coincide with and support those which I some time since communicated to the Society upon the same subject.

To give even the shortest account of all the experiments contained in Mr. Franklin's book, would exceed greatly the time allowed for these purposes by the Royal Society: I shall content myself therefore with laying a few of the most singular ones before you.

The effects of lightning, and those of electricity, appear very similar. Lightning has often been known to strike people blind. A pigeon, struck dead to appearance by the electrical shock, recovering life, drooped several days, eat nothing, tho' crumbs were thrown to it, but declined and died. Mr. Franklin did not think of its being deprived of sight; but afterwards a pullet, struck dead in like manner, being recovered by repeatedly blowing into its lungs, when set down on the floor, ran headlong against the wall, and on examination appeared perfectly blind: hence he concluded, that the pigeon also had been absolutely blinded by the shock. From this observation we should be extremely cautious, how in electrifying we draw

draw the strokes, especially in making the experiment of Leyden, from the eyes, or even from the parts near them.

Some time since it was imagined, that deafness had been relieved by electrifying the patient, by drawing the snaps from the ears, and by making him undergo the electrical commotion in the same manner. If hereafter this remedy should be fantastically applied to the eyes in this manner to restore dimness of sight, I should not wonder, if perfect blindness were the consequence of the experiment.

By a very ingenious experiment our author endeavours to evince the impossibility of success, in the experiments proposed by others of drawing forth the effluvia of non-electrics, cinamon, for instance, and by mixing them with the electrical fluid, to convey them with that into a person electrified: and our author thinks, that tho' the effluvia of cinamon and the electrical fluid should mix within the globe, they would never come out together through the pores of the glass, and thus be conveyed to the prime conductor; for he thinks, that the electrical fluid itself cannot come through, and that the prime conductor is always supplied from the cushion, and this last from the floor. Besides, when the globe is filled with cinamon, or other non-electrics, no electricity can be obtained from its outer surface, for the reasons before laid down. He has tried another way, which he thought more likely to obtain a mixture of the electrical and other effluvia together, if such a mixture had been possible. He placed a glass plate under his cushion, to cut off the communication between the cushion and the floor: he then brought a small

small chain from the cushion into a glass of oil of turpentine, and carried another chain from the oil of turpentine to the floor, taking care, that the chain from the cushion to the glass touched no part of the frame of the machine. Another chain was fixed to the prime conductor, and held in the hand of a person to be electrified. The ends of the two chains in the glass were near an inch from each other, the oil of turpentine between. Now the globe being turned could draw no fire from the floor through the machine, the communication that way being cut off by the thick glass plate under the cushion: it must then draw it through the chains, whose ends were dipp'd in the oil of turpentine. And as the oil of turpentine being in some degree an electric *per se*, would not conduct what came up from the floor, the electricity was obliged to jump from the end of one chain to the end of the other, which he could see in large sparks; and thus it had a fair opportunity of seizing of the finest particles of the oil in its passage, and carrying them off with it: but no such effect followed, nor could he perceive the least difference in the smell of the electrical effluvia thus collected, from what it had when collected otherwise; nor does it otherwise affect the body of the person electrified. He likewise put into a phial, instead of water, a strong purging liquid, and then charged the phial, and took repeated shocks from it; in which case every particle of the electrical fluid must, before it went through his body, have first gone thro' the liquid, when the phial is charging, and returned through it when discharging; yet no other effect followed than if the phial had been charged with water.

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He has also smelt the electrical fire, when drawn thro' gold, silver, copper, lead, iron, wood, and the human body, and could perceive no difference; the odour being always the same, where the spark does not burn what it strikes; and therefore he imagines, that it does not take that smell from any quality of the bodies it passes through. There was no abridging this experiment, which I think very well conceived, and as well conducted, in a manner to make it intelligible; and therefore I have laid the author's words nearly before you.

As Mr. Franklin, in a letter to Mr. Collinson some time since, mentioned his intending to try the power of a very strong electrical shock upon a turkey, I desired Mr. Collinson to let Mr. Franklin know, that I should be glad to be acquainted with the result of that experiment. He accordingly has been so very obliging as to send an account of it, which is to the following purpose. He made first several experiments on fowls, and found, that two large thin glass jars gilt, holding each about 6 gallons, and such as I mentioned I had employed in the last paper I laid before you upon this subject, were sufficient, when fully charged, to kill common hens outright; but the turkeys, though thrown into violent convulsions, and then, lying as dead for some minutes, would recover in less than a quarter of an hour. However, having added three other such to the former two, though not fully charged, he killed a turkey of about ten pounds weight, and believes that they would have killed a much larger. He conceited, as himself says, that the birds kill'd in this manner eat uncommonly tender.

In making these experiments, he found, that a man could, without great detriment, bear a much greater shock than he imagined: for he inadvertently received the stroke of two of these jars through his arms and body, when they were very near fully charged. It seemed to him an universal blow throughout the body from head to foot, and was followed by a violent quick trembling in the trunk, which went gradually off in a few seconds. It was some minutes before he could recollect his thoughts, so as to know what was the matter; for he did not see the flash, tho' his eye was on the spot of the prime conductor, from whence it struck the back of his hand; nor did he hear the crack, tho' the bystanders said it was a loud one; nor did he particularly feel the stroke on his hand, tho' he afterwards found it had raised a swelling there of the bigness of half a swan-shot, or pistol-bullet. His arms and the back of his neck felt somewhat numbed the remainder of the evening, and his breast was sore for a week after, as if it had been bruised. From this experiment may be seen the danger, even under the greatest caution, to the operator, when making these experiments with large jars; for it is not to be doubted, but that several of these fully charged would as certainly, by increasing them, in proportion to the size, kill a man, as they before did the turkey.

Upon the whole, Mr. Franklin appears in the work before us to be a very able and ingenious man; that he has a head to conceive, and a hand to carry into execution, whatever he thinks may conduce to enlighten the subject-matter, of which he is treating: and altho' there are in this work some few opinions,
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in which I cannot perfectly agree with him, I think scarce any body is better acquainted with the subject of electricity than himself.

XXXII. *A Letter to the Rev. Dr. Hales, F.R.S. from Captain Henry Ellis, F.R.S. dated Jan. 7, 1750-51, at Cape Monte Africa, Ship Earl of Hallifax.*

S I R,

Read June 13. 1751. **I** MAKE use of this opportunity of writing to you, less from the vanity I have of having such a correspondent, than the desire of contributing to his satisfaction, who esteems it his greatest happiness to promote the interest of mankind. At yours and Lord Hallifax's recommendation, I had your ventilators fixed on board of my ship, at Bristol. The following is a detail of the experiments, which I made to prove their utility.

1. I took a wax-candle, of eight to the pound, and drew it thro' a mold, to make it of one thickness from end to end: then weighed it exactly, and lighted it in the ship's hold; where I found it wasted 67 grains in 30 minutes; that place not being ventilated during 24 hours: but after six hours ventilation it wasted $94 + \frac{1}{2}$ grains in the same time.

2. I carried with me into the hold a plate of silver, well polished, and a lantern and candle, all blinded, except a round hole of about two inches diameter. I placed the plate at six feet distance from it; and with